Incident Summary #II-1014286-2020 (#17612) (FINAL)

SUPPORTING INFORMATION	Incident Date		May 15, 2020
	Location		Abbotsford
	Regulated industry sector		Boilers, PV & refrigeration - Refrigeration system
	Impact – Injury	Qty injuries	0
		Injury description	No injury reported
		Injury rating	None
	Impact – Damage	Damage description	Threaded connection failed and released ammonia that was intended to be contained within the refrigeration system.
		Damage rating	Moderate
	Incident rating		Moderate
	Incident overview		The ammonia piping connection within a refrigeration system of an industrial food processing facility failed and released ammonia in a cold storage room.
INVESTIGATION CONCLUSIONS	Site, system and components		Ammonia refrigeration systems are typically designed for maximum allowable working pressure of 250 psig on the high pressure side and 150 psig on the low pressure side. The refrigeration cycle contains four major components; compressor, condenser, evaporator and expansion devices. The refrigerant remains piped between these four components and is contained in the refrigerant loop. In cold storage facilities, food products are kept well below freezing for maintaining their texture and keeping them safe. The evaporators are installed in the cold storage rooms to cool the air going to the space by evaporating the refrigerant flowing through it. As the evaporator operates with a temperature below freezing, ice may form on its coil. This ice comes from the moisture present on the air inside the cold room that freezes when in contact with the evaporator coil. For de-icing and to avoid the excessive frost from obstructing the air flow through the evaporator coil, the system stops periodically to apply defrost procedures. The defrost line is connected to the evaporator through a special distributor. With this system, the hot gas flows directly through the evaporator coil, bypassing the expansion valve. To do this, the system controller activates the solenoid valves to divert the fluid flow through the defrost line. The solenoid valve on the refrigerant inlet side is closed, blocking the liquid refrigerant line. The solenoid valve on the defrost line (hot gas line) is opened, the heated vapors (high pressure and high temperature) are released from the compressors discharge and directed to the evaporator coil where heat is released to melt ice that has gathered on it, and then the low pressure and low temperature vapors returns to the compressors through the defrost condensate line. A defrost regulator valve on the suction line reduces the vapor pressure to the suction level before it reaches the compressor. As the defrost cycle operates periodically, the associated piping is subject to temperature variations causing expansion and contraction. The defrost condensate line is always insulated, and temperature variations cause condensation outside the pipe. Some old insulations do not have good vapor barriers, thus water entering under the insulation can cause corrosion The ammonia based refrigeration systems present a risk of accidental exposure to people from high concentrations of ammonia if the system, any components or any connections fail, and the ammonia is allowed to escape from the enclosed system. Exposure to high concentrations of ammonia is toxic to humans and can be harmful or fatal.

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Failure scenario(s)	• In cold storage room, the defrost cycle was turned on as programmed to operate periodically for de-icing the ice built up on the evaporator coil. • The defrost condensate line was going through expansion and contraction because of the temperature variation. • The defrost condensate line was insulated and water entrapped under the insulation also cause corrosion on piping. • Ammonia from the piping connection of the hot gas defrost line was released which triggered the audio ammonia alarm. • The ammonia monitor located outside the cold storage room initially showed 201 ppm and then dropped to 128 ppm within 10 to 15 minutes when the hot gas system was shut off. • Doors were opened and Industrial fans were used to move ammonia fumes out of the cold storage room and out of the building. When the workers went to open the cold storage room's door, their personal monitors were reading 0 ppm.
Facts and evidence	Plant activities • The evaporator in the cold storage room was in operation. • The hot gas defrost cycle was turned on at 5:00am as programmed and the alarm went off at 5:06am. • Maximum ammonia reading noted was 201 ppm. • The hot gas line was shut off as it was known that the defrost cycle was auto started at 5:00 am, and then the ammonia level dropped to 128 ppm in 10 to 15 minutes. • A maintenance contractor was contacted • The industrial fans were turned on and exterior doors were opened to help exhaust the ammonia. Maintenance contractor's activities • Maintenance contractor isolated the refrigerant liquid line and hot gas line. • The maintenance contactor investigated the leak and performed pressure test by using nitrogen. • The leak was found on the threaded connection (Tee joint) of defrost condensate line. • Fig. 4 shows the leak was coming from the threaded portion of Tee. • The defrost condensate line (1") broke during disassembly of threaded joint. • The defrost condensate line was corroded from outside, and thus replaced (repaired) and then pressure tested before use. Phone Interview with Chief Engineer • Reported the above mentioned plant and maintenance contractor's activities • Informed that the piping was installed in 1980s and it was not inspected as it was covered with insulation.
Causes and contributing factors	It is very likely that the threaded joint failed because of the expansion and contraction of the piping joint due to the hot gas defrost cycle process for the evaporator. The corrosion under insulation may have also exaggerated the threaded joint failure and caused the ammonia leak.

Fig. 1: Evaporator (Image provided by repairing contractor)

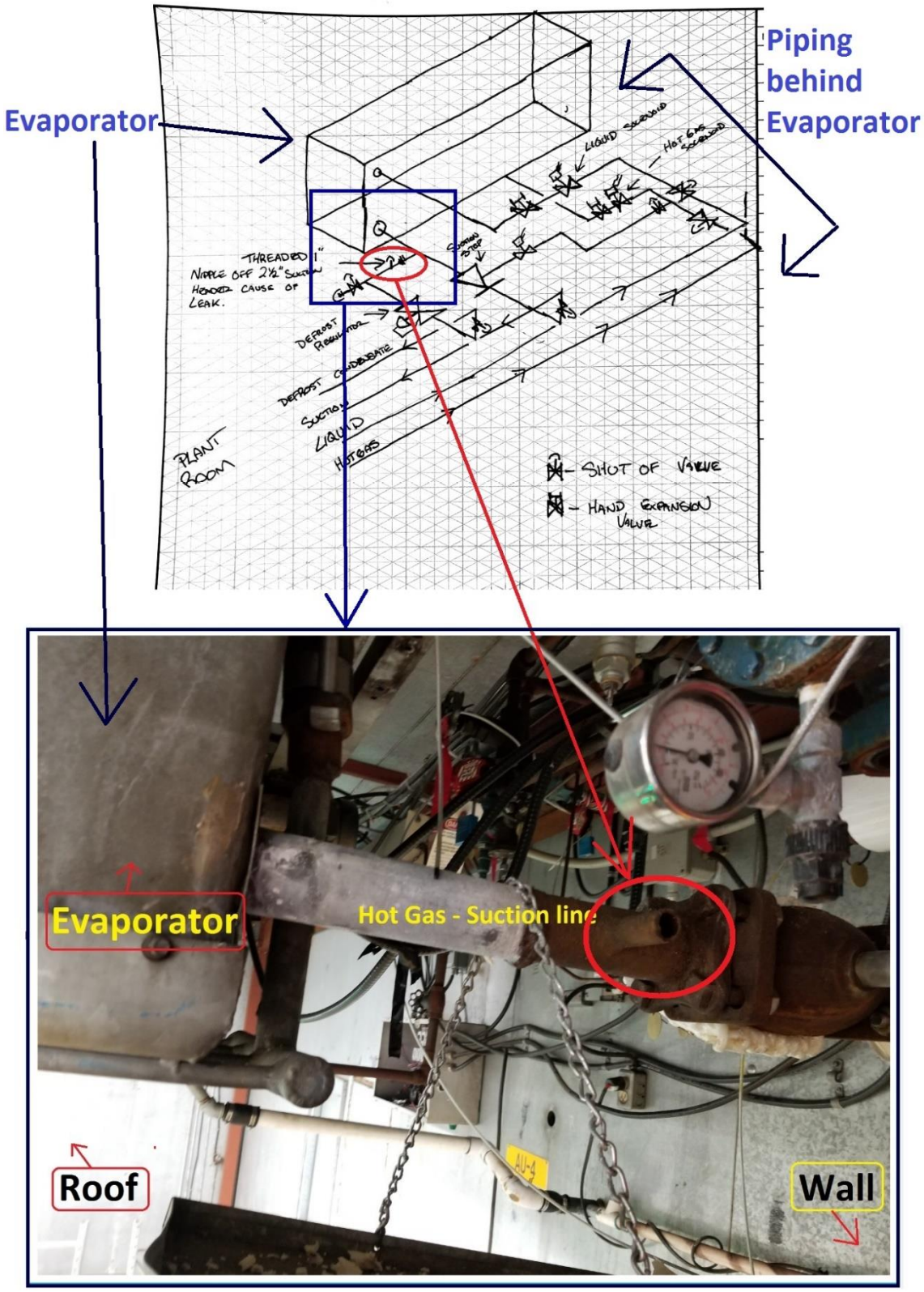

Fig. 2: Location of Leak (Image and diagram provided by repairing contractor)

Fig. 3: Location of Leak (Image provided by repairing contractor)